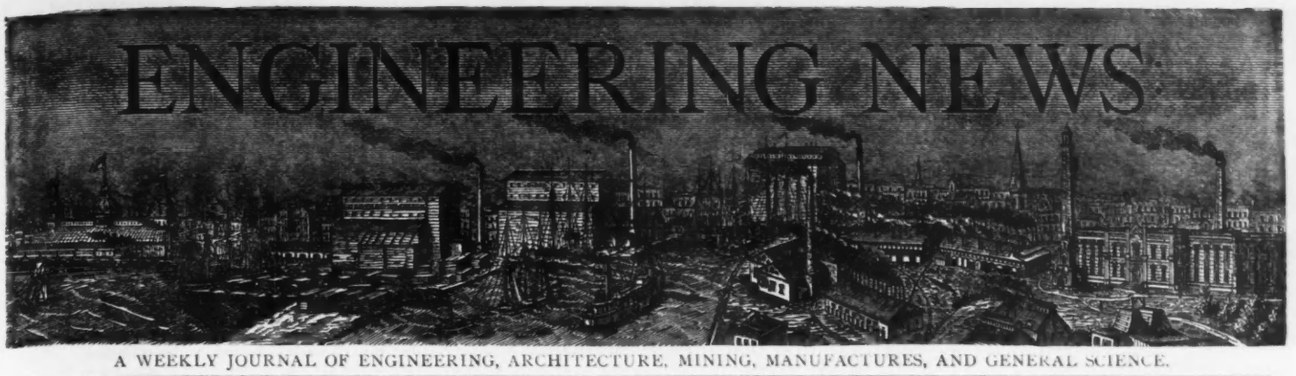
ENGINEERING NEWS



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CIVIL ENGINEERS' CLUB OF ST. LOUIS.

Report of March Meeting.

(Reported for Engineering News.)

A meeting of the Club was called by the President on Saturday evening, March 4th, 1876, at the office of Messrs Flad and Pfeifer, No. 600 Olive St. The meeting was called to order by the President, Col. Flad, and the proceedings of the last meeting were given by the Secretary.

The Secretary presented an invitation from the American Society of Civil Engineers to make use of the rooms of the society both in New York and Philadelphia.

Moved to return thanks, and to send a list of members to the Secretary of the society, also moved to return thanks and send a list of members to the Secretary of the Franklin Institute for a similar invitation presented last month.

The committee on the memorial of the Boston Society of Engineers, on the Metric System, reported, and the Club moved to adopt the memorial and the form of the petition to Congress, and to offer to co-operate with the Boston Society in their movement, the Secretary to communicate with the Society concerning such action.

The Secretary then reported that on the morning of the 1st inst., at Chattanooga, Mr. Henry Pomeroy, A. M., C. E., member of the Club, had passed from this life dying from Inflammation of the Brain, consequent to Dysentery from which he had been a constant sufferer for the past eleven years.

Mr. Pomeroy was born in Rochester, N. Y., Nov. 30, 1824. He served a short time in the U. S. Navy, and at sixteen entered Union College, and after graduating thence studied engineering at the Rensellaer Polytechnic Institute, Troy. He was Assistant Engineer upon the Erie canal, and afterwards was Resident Engineer on the Portage Division of the Genessee canal. He was employed on the Lake Shore and the Toledo, Wabash and Western R. R., building that part of the line from Toledo to Fort Wayne. He then became Professor of Engineering in the Lawrence University at Appleton, Wisconsin, where he remained till the breaking out of the war, when he entered the army serving as Major and Colonel of a cavalry regiment, and where he contracted the disease which resulted, after years of suffering, in his death.

After the war he was employed for a while as Chief Engineer of a railroad line in Alabama, but finding the active life too severe for him, he engaged as Professor of Mathematics and Astronomy in Washington University where he remained five years, but finding the climate of St. Louis too trying for him he took charge of the High school at Chattanooga, which position he retained till his death. He became a member of the Club in March 1871. He leaves a wife and three children.

Resolved by the Club as follows: That we deeply deplore the loss of an esteemed member of the Profession, and that we sympathize most heartily with his bereaved family in their loss.

The Club then listened with great interest to a paper by Mr. Chas Pfeifer, upon "Arch Bridges." Mr. Pfeifer is so well known from his connection with the St. Louis bridge that this paper is of special interest and value. Mr. Pfeifer's paper dealt with the circular arch first, in an entirely general manner, considering first the two reactions from the abutments to have any directions and to be applied at any distance from the neutral surface of the rib. After deducing general expressions for this general case, specific cases followed. The arch as a curved girder, and the three-hinged arch were shown to be special cases of the general form and the formulæ readily deduced. The three forms of most difficulty were those, 1st, with fixed ends, of which the St. Louis bridge is the largest example and may be taken as a type. 2d, a form original with Mr. Pfeifer in which the ends are square but are not fixed to the abutments, and rest sometimes on one edge and sometimes on the other. An arch erected by Mr. Pfeifer in Pittsburg is the only example known of this form. 3d, The arch hinged at the two ends "Coblenz" type. Formulæ for these three types were then deduced from the general one, and some general remarks followed. A brief discussion took place between Messrs. Pfeifer, Meier, and Smith. The novelty of the paper being remarked, and the avoidance of errors which had been made by Airy, Bell, and Baker, but not made by Rankine or Winkler, and his follower, Du Bois, was pointed out, and the Secretary authorized to have copies of the paper made.

A discussion on forms of furnaces for "smoke burning" was then started by Mr. Whitman, by a description of an apparatus somewhat on the "regeneration" system, and very much like some of M. C. Wye Williams' forms; this discussion was entered into by Messrs. Meier, Mills, Flad and Smith—various devises were mentioned and experiences narrated. They may be summed up by saying that nothing had been yet found by any present to work with careless and ignorant firemen.

On motion adjourned, after thanking Messrs. Flad and Pfeifer for the use of their office.

American Society of Civil Engineers.

No. 4 Twenty-Third Street,
New York, Jan. 25th, 1876.

Sir:—To aid in a proper representation of American engineering progress and practice at the Centennial Exposition, this Society, at its Annual Meeting, appointed a committee to consider the subject, and to take such action as might seem desirable.

It is proposed—*first*: "to urge engineers who are or who have been in charge of important, novel or interesting works; railroad, canal and other public corporations, and especially builders or manufacturers willing to make their works known, to present such specimens, models, plans, photographs and descriptions as shall give to visitors at the Exposition an adequate and correct idea of engineering progress and practice in this country, and to exhibit the same either in groups or under the general classification, as may be preferred; and *second*: to have a secretary in attendance during the Exposition, to give such detailed information as by an inspection of the models, plans, etc., exhibited, visitors may be led to ask for." With this in view, various sub-committees have been formed.

In furtherance of the object thus set forth, the Sub-Committee on Foundations and Masonry earnestly requests you to contribute for exhibition at the Centennial Exposition such models, plans, photographs, reports and descriptions of works belonging to this class, actually constructed in this country, as you may now have, or be willing to prepare. Models, plans and reports of the earlier works done by American engineers, or illustrative of the methods employed in their construction, will, it is believed, prove specially interesting, while it seems the plainest duty of American engineers to exhibit proofs of the skill they have acquired in the new processes they have so successfully employed in laying foundations and building masonry under extremely difficult circumstances.

It is proposed to devote the space allotted to the Society in the Exposition Buildings, to the exhibition of—*first*: albums of plans, photographs and descriptions of works; and—*second*: drawings and models of works and of machinery used in their construction, made generally upon a scale of one-eighth or one-fourth inch to the foot. Models or drawings of small machines, or of details of larger ones, may be made upon a larger scale.

Printed copies of reports and descriptions, which it is hoped will be largely supplied, will be judiciously distributed or sold at cost, as exhibitors may be pleased to direct.

As the total space to be allotted to our Society must be determined upon immediately, the Sub-Committee on Foundations and Masonry asks that you will at the earliest possible moment, inform the undersigned at the Society's *rooms*, by letter, what you will contribute for exhibition and the space it will require.

The American Society of Civil Engineers, in this action, *only* desires to co-operate with those charged with the management of the Centennial Exposition in their efforts to make it fully and clearly illustrative of the progress and present status of American engineering, and in this effort we earnestly ask your immediate and active assistance. Respectfully,

Address W. Sooy Smith,
Chairman Sub-Committee VI.
Care American Society of Civil Engineers,
4 East Twenty-Third St., New York.

Ventilation of Sewers.

The importance of providing some means for the ventilation of sewers is made more apparent each year by scientific research and experience. Unless the sewage matter is speedily and wholly discharged from sewers, decomposition, and consequently the generation of noxious gases, takes place. Such sewers, if not properly ventilated, are only elongated cesspools,—retorts for the production of deadly poison which must find egress either at the street inlets, or through the water-traps of house connections into the close rooms of dwellings. Sluggish sewers without free communication with the open air are even more dangerous than steam boilers without safety valves, It is commonly, and very erroneously, supposed that water-traps are proofs against the escape of sewer gases through them. An ordinary trap of three inches depth of water will resist the passage of sewer air or gas only when the pressure of the same is less than .1 lb per square inch. A strong wind blowing into the mouth of an unventilated sewer, or the compression of the air in the sewer caused by the increased volume of water during heavy rains, will often create a sufficient pressure to cause the sewer gas to break through the water-trap and find its way into the close apartments of houses, poisoning the air in them, and often causing disease and death. The inlets of the sewers first constructed here are not trapped, and hence furnish a means of ventilation. These sewers are really less dangerous to health than those constructed during the last four years, the inlets of which have all been built with traps, although the odor escapeing at times from the uptrapped inlets is exceedingly offensive to persons walking upon the streets. It is better that the poisonous gases of sewers should escape into the open air than that they should find their way into the houses in which we live.

Several means have been devised for the ventilation of sewers, the best, simplest and least expensive of which is an arrangement brought into use by Baldwin Latham Esq., an English Engineer, which may be adapted to the ordinary manholes built in the center of the street. It consists of galvanized wire netting arranged spirally on a light galvanized iron frame, upon which charcoal is placed. This frame completely fills the manholes crosswise so that openings being made in the manhole-cover, the sewer air, impelled by currents from the mouth of the sewer, or by the pressure due to extra amounts of water in the sewer, and also being warmer and lighter than the air without, rushes up through or between the layers of charcoal by which it becomes purified, and thence through the openings in the covers into the open air. Such arrangements, or others equally good, would insure the efficiency of water traps as a means of preventing the ingress of sewer air into houses. Without some means of ventilation, water-traps are *not* a sure barrier to the escape of poisonous sewer gases.

Measures should be taken on the part of the city to obtain some means of ventilation, at the highest points at least, of all the main sewers not already ventilated with the old style of untrapped inlets. Every sewer should be so constructed and arranged as to promote the *health*, as well as the convenience, of the people usin it.

E. P. Augur, *City Surveyor.*
Middletown, Ct.

The numbers for June, July, and August of "The Engineer, Architect and Surveyor," for 1874, are wanted at this office, and we will give *one month's subscription* to Engineering News, Vol. 3, for either one of these numbers that is sent us.

THE RIPARIAN QUESTION.

A paper read before the Civil Engineers' Club of the Northwest, February 7, 1876, by SAMUEL S. GREELEY.

The thorough Engineer must be a many sided man, of wide and varied knowledge drawing into his service the arts of many men, and making himself their fellow worker. As he uses their skill or knowledge, he must know something of their methods, and I know no man to whom the Engineer or the Land Surveyor is tangent at so many points of his circumference as the Lawyer. I am rarely on the witness stand in a land case without finding that the lawyer is twice a lawyer if he happens to have been once a surveyor; and in my own practice I see constantly how a Surveyor might be reinforced by some knowledge of the law. In preparing this paper, then, I have no ambition to trench on the province of the jurist, and no hope of discovering new facts or principles; I only collate decisions and statements of principle which I find scattered through the books, and try to apply them to actual cases which may arise within the practice of any member of the Club.

The boundary line between great kingdoms or states is often vague and unsettled, and the frontier is therefore specially subject to forays and disturbances which make life uncertain and miserable to the inhabitants. The narrow, but ever changing, border land which divides the mysterious domain of the sea from terra firma, is particularly unsettled and liable to dispute. At times, all the vast forces of nature seem combined to tear a fragment from the land and subjugate it to the waves: again, man, with efforts that seem insignificant in their extent, but powerful in their cunning and persistency, re-annexes the lost territory, and with it conquers some portion, which the sea had hitherto held unquestioned.

A great river, with angry flood, eats away whole farms and villages on one side of its bed, and scatters the material with capricious and deceitful prodigality on the other side, in broad acres of fertile alluvion. Frost, rain, and waves stealthily gnaw away bluffs and shores, while the currents drag away the stolen particles and hide them one by one in the foundations of beach and bar. Man, in self-defence, throws out his piers, fascines or breakwaters, either to prevent the plunder or to intercept and regain the booty. Thus the sea shore and the river bank are the theatres of constant assault by the flood and tide and of endless defence and reprisal by man. Twice in every day the sea gathers her crested hosts, and hurls them over rock and beach, as if in living testimony to the uttermost extent of her domain: but no sooner is her farthest border reached, than she peacefully retires, and surrenders a wide space for brief human occupation. Over this space alternate sovereignty is mutually conceded by the contending parties. This tireless warfare between man and nature with its alternate advance and retreat, is brought strongly to the notice of the legislator and the jurist by its effect on the rights and interests of the immediate combatants on the human side of the line. So long as the soil is hidden by the tides, it forms part of a majestic realm, one and indivisible; but, restored to terra firma, its unity crumbles, and the fragments are grasped by a thousand conflicting human claims and interests, which were silent only under the duress of the mighty invader.

Any change of contour of a river bank, or of the shore of a sea or lake, produces either loss or gain to the owners of abutting lands, and requires a readjustment of their boundaries, especially in the case of increase. The common law vests with the fee of water-bounded land certain privileges, such as the right to construct and occupy wharves, the right to gather seaweed and other waifs deposited at high water mark, and the fee of accretions formed upon the land by slow and imperceptible degrees. To these privileges common usage has given the name of Riparian rights. Of these the last named is perhaps the most important, and it is the ownership of accretion and its proper division among co-terminous owners that I principally consider in this paper. And it is proper first to note what a water-boundary is.

Hall's essay on the Rights of the Crown and the privileges of the subject in the sea shore of the Realm, says — "Over the British Seas the King of England claims an absolute dominion and ownership as Lord Paramount against all the world. * * * His subjects do, by the common law of the realm, acknowledge it to be his ancient and indisputable inheritance, and he is Lord of the great Waste, both land and water." "This dominion extends, not only over the open seas, but also over all creeks, ports and tide rivers, &c, as far as the reach of the tide."

The Courts and the law writers on this subject make three divisions of the earth's surface into, — 1st, Sea bottom; "Which never is known to become dry by changes of the surface of the sea." 2d, terra firma or dry land, "which is wholly exempt from the action of any tides, and ranging down to ordinary high water mark;" and, 3d, sea shore, which they describe as "that portion of land adjacent to the sea, which is alternately left dry and covered by the ordinary flux and reflux of the tides." It is clear that under English Common Law, the sea shore is included with the sea bottom in the Royal domain, the subject having no propriety therein except by grant of the king, beyond ordinary high water mark. And Kent says "in America our great navigable lakes are properly regarded as public property, and not susceptible of private property more than the sea." Commentaries, Vol. 3, p. 430, note.

On non-tidal and unnavigable rivers, the law clearly places the boundary at the thread of the stream, and makes the river bed private property, subject to the public easements of passage and fishery. It is equally plain from what has gone before that on the sea and on all tidal waters, and also on the great lakes, the limit of private property is at ordinary high water.

The law in regard to rivers, navigable but without tide, is thus laid down in the case of Railroad Co. v. Schurmeier, 7 Wallace, 272, Dec. 1868. "Rivers were not regarded as navigable in the common law sense, unless the waters were affected by the ebb and flow of the tide, but it is quite clear that Congress did not employ the words 'navigable' and 'not navigable' in that sense, as usually understood in legal decisions. On the contrary, it is obvious that the words were employed without respect to the ebb and flow of the tide, as they were applied to territory situated far above tide waters, and in which there were no salt water streams. Viewed in the light of these considerations, the Court does not hesitate to decide that Congress, in making a distinction between streams navigable and those not navigable, intended to provide that the common law of riparian ownership should apply to lands bordering on the latter, but that the title to lands bordering on navigable streams should stop at the stream." See Fig. 1

The question in the case last quoted was whether the title to a fractional section of land bordering upon the Mississippi river, containing 9.28 acres, carried with it a bar or island containing 2.78 acres, not shown on the Govt. plat, lying outside the meander line, submerged at high water, and separated from the main land by a channel sometimes without current, but never dry, the whole having been filled and graded, and laid out as part of the city of St. Paul. The Court held that the island was included with this fraction though the purchaser got 12.06 acres, while paying for 9.28 acres.

Of the meander lines the Court says:—"The meander lines run in surveying fractional portions of the public lands bordering upon navigable rivers are run, not as boundaries of the tract, but for the purpose of defining the sinuosities of the banks of the stream, and as the means of ascertaining the quantity of land in the fraction, to be paid for by the purchaser.

This ruling of the U. S Supreme Court confirmed the judgement of the Supreme Court of Minnesota rendered in Jenuary 1865, which held that the river and not the meander line was the boundary, and that the patent conveyed the title to land *at least* to low water mark.

In Seaman v. Smith, 24 Ill., 521, April 1860, the question was upon the water boundary of a tract fronting on Lake Michigan near Twelfth St., in this city. The Court says:—"The line at which the water usually stands when free from disturbing causes, is the boundary of land in a conveyance calling for the lake as a line. The portion of the soil which is only seldom covered with water may be valuable for cultivation or other private purposes. And the line at which it usually stands, unaffected by storms or other causes, represents the ordinary high water mark on the ocean."

The power of topographical features in moulding the political, as well as the social, forms of a people, may be easily traced in this branch of English law.

England is an island, and not a continent; her rivers are thefore short, and the head of navigation is rarely if ever above the flow of the tide.

There is probably no navigable water in Great Britain beyond the reach of the tides; so that in the eye of the law, as in fact, the presence or absence of tidal action makes the difference between navigable and non-navigable water.

But the great Continent of North America, with its rivers, bearing steamers three thousand miles above salt water, with its fresh water seas, whose commerce is probably many times larger than that of the Mediterranean, must modify the old definitions, in adopting a system of common law which has grown up under narrow limitations.

Here a river or a lake is classed as navigable, not because its water is salt, but because ships can navigate upon it.

Lake Michigan is a sea whose high water mark and low water mark coincide, in other words a sea without a "foreshore." It lacks that zone of debateable ground which is subject to alternate possession by man and the waters.

Whatever, therefore, may be predicated of either high water mark or low water mark, may in general be predicated of the average or usual water mark of the lake.

There is indeed a periodic fluctuation in the great lakes extending through a series of years, and making a difference of about three feet in the height of the water. But the variation in horizontal position of the line from month to month is too small to be regarded.

With the above limitations upon the extent of water front property, it is not easy to see by what right solid piers are built by private owners far out into the lake, not in the exercise of their right to protect their land or to ship and receive freight upon it, but for the purpose of obstructing the litoral current and producing accretion.

If nearness to the lake be an element of value in land, then the removal of the lake shore from it is a diminution of its value, and a wrong to its owners.

Where this is done by the Government, as by the building of the river piers, or of the new breakwater now in process of construction, no objection can be made. But in many places private owners are adding to their own estates, and reducing the value of their neighbor's premises, by serious encroachments upon the public domaine in the lake, contrary, as I believe, to law and to right.

Hall's essay, previously quoted, says upon this point,—"The Crown has a title to prevent, by application for interdict, any encroachment by the proprietors of grounds adjoining the seashore upon the enjoyment of the shore by the lieges for the purpose of passage and relaxation. A proprietor of ground described by his title as being of a specified extent and as bounded by the seashore, has no right to enclose that part of the shore which is covered by the sea only in ordinary spring tide, over which the public has been from time to time in the habit of passing, and over which he cannot prove any past use or possession by himself."

A decisive application of this doctrine of the English Common Law to American tide waters is made in Stevens v. Paterson and Newark R. R., 5 Vroom, 532, New Jersey, Nov, 1870, as follows:

"The State is the absolute owner of the land in all navigable water within its territorial limits, and such land can be granted to any one, either public or private without making compensation to the owner of the shore."

"By the local custom of this State (N. Jersey) the shore owner can reclaim the land between high and low water marks, but such privilege is a mere license, which the Legislature may revoke at any time before execution."

"The rights confessed by the wharf act are also revocable before execution by the land owner,"

Beasley, Ch. J., quoting in this case an old English authority, says "It cannot fail to be observed how entirely this case explodes the assumption that the riparian proprietor has any common law right to extend his front, either by filling in or by erection of a wharf. Such acts would have been trespasses on the private property of the Sovereign. * * * * *

"I think it safe to assert that no English lawyer, speaking either from the bench or the bar, has ever asserted that the owner of land along the shores of navigable water has any peculiar right, by reason of such property, to the use of the water or the shore."

Ought not the Government, holding this great submerged domain in trust for the people, to guard it against the encroachments of private interests, or if it grant the right to reclaim, should it not exact an equitable compensation, to enure to the benefit of the people? There are very wise suggestions to this end in the Report of the Riparian Commissioners of the State of New Jersey for 1875, as follows:

"The State title to these lands is becoming more widely and thoroughly understood and her wise and just policy of protecting such title for the common good of her citizens is becoming increasingly perceived and approved, * * *

"The Commissioners would respectfully express their conviction of the wisdom and justice of the rule to which legislative action has of late been conformed, in declining to make grants to riparian owners without compensation."

Some 50 years ago the Hon. Francis Gray, of Boston, accidently found in the Boston Athenaeum, and saved from oblivion, a curious and very important manuscript entitled the "Boddie of liberties of Mattachusetts Baye." One of its hundred sections is as follows:

"Every Inhabitant that is an householder shall have free fishing and fowling in any great ponds and Bayes, Coves and Rivers, so farre as the sea ebbes and flows within the precincts of the towne where they dwell, unless the freemen of the same towne or the Generall Court have otherwise appropriated them, provided that this shall not be extended to give leave to any man to come upon others proprietie without there leave."

In the printed code of 1660, the above section is repeated but with the different proviso—"that no towne shall appropriate to any particular person or persons any great Pond containing more than ten acres of land, and no man shall come upon another's propriety without their leave, otherwise than here expressed. The which clearly to determine, It is Declared, That in all Creeks, Coves and other places about and upon Salt water where the Sea ebbs and flowes, the proprietor of the land adjoining shall have propriety to the low water mark where the sea doth not ebb and flow above a hundred Rods, and not more wheresoever it ebb further."

This grant of flats not over one hundred rods wide to proprietors of abutting uplands is peculiar, I believe, to Massachusetts, and to Maine, which was then a part of Massachusetts; it certainly does not conflict with the general principle that "by common law the title of the litoral owner on the sea shore extends to ordinary high water mark."

The law of property in accretion is stated by Blackstone in these words:—As the land gained from the sea either by alluvion—*i. e.* by the washing up of sand or earth so as in time to make terra firma, or by dereliction, as when the sea sinks back below the usual watermark, in these cases the law is held to be, that if this gain be by little and little, by small and imperceptible degrees, it shall go to the owner of the land

adjoining, for "*de minimis non curat lex*;" but if the alluvion be sudden and considerable, it shall go to the King as Lord of the Sea."

Whether uplands be increased by alluvion or by annexation of flats or of unreclaimed land, in either case the property must be divided among the co-terminous owners, and where judicial aid has been invoked, the courts seem to apply the same principles of division in all these cases, varying their application only to suit peculiar contours of shore or the accession.

Kent in his Commentaries (vol 3, p. 430) says—"Light is thrown on the principles according to which alluvial accessions should be divided by the similar case of the division of flats among owners of upland. The fundamental rule is said to be that the flats are to be so divided as to give to each parcel a width at its outer or seaward end proportional to that which it has at high water mark. The dividing lines are generally to be drawn in the most direct course from high to low water mark, and the flats in front of each proprietor's uplands should, if practicable be as wide at low as at high water mark."

One of the earliest and oftenest quoted cases relating to this subject is that of Deerfield v. Arms; 17, Pickering 41. Sept. term 1835, in which Judge Shaw's opinion contains the following:—

"A rule which appears to us to be applicable to the present case is found in a work of the Civil Law, cited by the Learned Counsel, entitled "a collection of new decisions," by Denisart, published in France in 1783. It is in the form of a dictionary, and this rule is under the head Alterrissements. It is founded upon the obvious consideration, that in many cases lands which border upon navigable rivers derive a great part of their actual value from that circumstance, and from the benefit of the public easement thereby annexed to such lands, and that being wholly deprived of the benefit of that situation would operate as a great hardship, and do real injustice to a riparian proprietor, although he should obtain his full proportion of land measured by the surface, This injustice will be avoided by the proposed rule." Which, reduced to its lowest terms, is substantially as follows—"Measure the length of each proprietor's frontage on the original water line, and also the total length on the new water line, taking in each case the general line, and not the actual length on the margin, if it happens to be elongated by deep indentations or sharp protections. Divide the new frontage among the proprietors in proportion to their respective lengths of frontage on the old line. Draw straight lines from the points at which the proprietors bounded respectively on the old, to the points of division then determined on the newly found shore.

A valuable discussion of the question is found in Wanson v. Wanson 14, Allen, Mass. 71 Jan. 1867. In this case the upland of the parties bordered on a deep salt water cove in Gloucester, called Coos' cove, and the question was upon the division of the adjacent flats. See Fig. 2.

Commissioners were appointed under the statute to partition their flats and those on each side as far as the lines were co-dependent. The sketch showing high and low water marks, and the occupation of the parties, is copied from the commissioners' map forming part of the case. The commissioners report that as the irregular contour of the shore made this a peculiar and difficult case, they proceeded, in a novel method. They draw a tangent or base line from headland to headland across the mouth of the cove; then in order to fix the exterior limits of the flats to be partitioned, they draw a perpendicular to this base at the northerly end, and a line deflecting 74° 53′ from it at the southerly end, these lines leaving, in their judgment, a proper extent of flats outside for the adjoining owners not parties to the suit. They then draw curved parallels so as to divide the space in front of the uplands into zones ten feet wide, Each zone is then divided so that each party shall have an equal area in each zone, and the irregular division lines running around the zones marked A 1, B 1, C 1, are reported as the lines of partition, They show also, at the request of parties other modes of division as follows:

Method No. 2. Dividing the base line into parts proportional to the respective fronts at high water mark, and drawing straight lines from the division points to the terminal points at high water mark.

No. 3. Dividing the whole frontage on low water mark between the end lines into parts proportional to the respective high water frontage, and drawing straight division lines A 3, B 3, C 3.

No. 4. Dividing only such portion of the low water frontage as lay within the base line in the same proportion.

The Court rejected the first method, the one reported by the commissioners, as being nove and unprecedented, artificial and complicated, requiring much mathematical skill and elaborate calculation, saying further,—"it does not give each proprietor a width on his outer line either equal or proportional to what he has at high water mark. It determines the width of the parcels of flats by a series of arbitrary lines, many of which fall partly within and partly without the flats to be divided, The dividing lines do not run straight to the seaward limit, but are curved and serpentine and therefore unsuited to occupation by wharves and buildings, And the division is specially unfair to Davis.

The Court comment shortly but adversly on methods 2 and 4, and rule strongly in favor of method 3, making the proportional division on the whole low water front.

This case is specially interesting from the exhaustive ingenuity of the commissioners, and the discriminating opinion of the judge. The commissioners seem, in fact, to have done every possible thing in the way of division except to wade out bare legged, and measure the mud by the bushel.

The Court in this case lays down the following as the leading rule established for such divisions:

1st. The dividing lines are generally to be drawn on the most direct course from high water mark towards the low water mark.

2nd. Wherever practicable each proprietor is entitled to the flat in front of his upland of the same width at low water mark as at high water mark.

3rd, Which is perhaps the fundamental rule, underlying and controlling all the others. the flats are to be so divided as to give to each parcel a width at its outer or seaward end proportional to that which it has at high water mark.

Quite a different rule had been laid down some 3 years earlier in the case of Emerson v. Taylor 9 Greenleaf (Maine) 44 June 1832 as follows—"Draw a base line from one corner of each lot to the other at the margin of the upland, and run a line from each of these corners at right angles with each base line to low water mark. If the line of the shore is straight, the side lines thus drawn will be identical; but if by reason of curvature of shore, they either diverge from or conflict with each other, the land enclosed by both lines, or excluded, as the case may be, is to be equally divided between the adjoining proprietors." See Fig. 3.

In this case the rule works fairly and is of very easy application, because under it the line between any owners can be fixed without reviewing or disturbing the lines of other parties on either side. But that it is not a rule of universal value will be shown by supposing the outer lines of flats or accretions to be, say twice as far out from high water mark. With a moderate extension of the side lines, lots 5 and 6 would be cut off entirely from access to low tide, and their owners would thus suffer the hardship alluded to by Judge Shaw in the case above quoted.

In Gray v, Deluce 5 Cushing 10 (Nov. 1849) and in Stone v. Boston Steel Co. 14 Allen 230 it is held that "where the shore line of a cove does not depart much from a straight line, the flats may be divided by drawing a base line from headland to headland, and running straight lines at right angles with the base line from the ends of the division lines of the uplands to the low water mark, even if the sea never wholly ebbs and flows beyond the base line, provided the situation and shape of the channel are not such as to require a different mode of divisions." See Figs. 3 and 4.

In the latter case, some of the side lines of the upland lots were oblique to the shore line and to the base, and it was held that "the side lines were not to be extended in the same direction as those of the upland."

It is evident upon inspection that this rule could not be equitably applied to a shore sloped like that in the Wanson case, nor to one like that shown in Emerson v. Howard.

The case of O'Donnell v. Kelsey 4, Sandford 202, introduces some considerations not brought to view in the cases cited above. After rehearsing the rules laid down in those cases the Court says "the rule that the boundary line between co-terminous proprietors on a curved shore shall equally divide the angle of indentation, is incapable of application where the shore is curved diagonally, and the outer or permanent line is straight."

"The law gives no fixed and certain mode of drawing the boundary line in such cases. It only lays down the principle that each riparian proprietor shall receive his rateable proportion of front on the outer or new water line, and that the boundary lines shall be drawn at right angles, or divergent or convergent to the shore according to whether the new exterior line equals, exceeds, or falls short of the old shore line."

"The settlement of the lines is a question of much dificulty, and a mode of division which, under some circumstances would be fair, would under others, be the reverse."

"In this point of view the practical location by the proprietors themselves of their respective boundaries, is entitled to great weight, and where a mode of division has been adopted generally, no one of the owners ought to be allowed carelessly to disturb it.

"Therefore when the proprietors generally have settled their boundaries so as to make them conform to the direction of the streets in a city, and have filed a map of their lots, with boundaries conforming to streets, in the clerk's office, no one of them may disturb it."

The court here allows a certain weight to a general adoption by owners of some plan of distribution, and also to municipal convenience in the direct extension of street lines within a city.

In these respects this case seems to be strongly supported by that of Valentine v. Piper, 22 Pickering 85, April 1839, which I merely refer to without quotation.

Perhaps the largest and most valuable single natural accretion in this country is that which has formed on the lake front of Kinzie's addition to Chicago, between the North Pier and Chicago Avenue.

The area of made land since 1833, the date of subdivision, is about 70 acres, and its present value is between a million and a half and two million dollars. This map shows the lake shore of 1833, 1859 and 1872:

A waif of this magnitude could hardly be divided in peace among its several owners, and there was in fact sharp litigation for many years over the division line in the south part of it. That the controversies were not much more numerous was due to the fact that the owners of the adjacent shore were few, and that the interest of all, as well as the city, lay in the extension of the streets in straight lines to the new shore.

Two differing plans have been ruled at different times by the county for its division, and still a third plan has been tacitly accepted and carried out by the owners.

In Jones vs. Johnston 18 Howard 15, Dec. 1855, the Supreme Court of the United States, ruled that the whole new front of accretion along the river pier as well as along the lake as far north as accretion extended, should be measured and should be divided pro rata among the owners, along the old shore line, as shown in figuer 6.

In Johnston v. Jones 1 Black 209 Dec. 1861, a map similar to this one having been put in as evidence, making visible to the eye the effect of the former ruling, the court held that the piers front should be excluded from the computation and that pro rata division should be upon the lake front alone, as shown here, producing quite a different effect.

But about that time the interest of Mr. Jones, south of North Water Street was sold to Mr. Ogden who owned thence north for several blocks. Thus three owners, Mr. Ogden, Mr. Newberry, and Mr. Lemoyne, owned the whole lake shore front of Kinzie's addition about half a mile in extent; and they extended the street of Kinzie's addition due east to the new shore, and adopted these as the division lines or the three estates as shown in fig. 6.

It would seem from the foregoing examples, that where the line of shore runs in a direction diagonal to the section lines, accretion cannot be divided by extending the section lines or the lines of Government subdivision, but that all made land outside the shore line as it was at the time the Government conveyed it must be divided so as to give to each owner his proportional share of the new frontage. This will of course deflect the section lines and other lines of ownership from their original courses, and will be very likely to cause some inconvenience in the extension of streets already laid out on the old land. Where the shore line is nearly straight and makes a small angle with the section lines in either direction, coterminous owners may, by common consent, extend the Government lines without injustice to each other. But I think such a mode of division could not be forced upon an unwilling owner.

Take the case where the corner of a section was cut off by the old shore on a line at an angle of 45° from the section lines as shown in fig. 7. There seems to be nothing to indicate whether the north and south lines, or the east and west lines shall be extended.

If both are extended, the legal dimensions of the fraction are filled out, but it loses its whole water front. Moreover a new fractional section is formed to which neither the Government nor any body else has title.

In such a case equity and convenience would seem to require that the lines should run as nearly as possible at right angles to the old shore.

In the town of Lake View the general course of the lake shore departs not more than 10° to 30° from the meridian, and the general tendency has been in cases of accretion to extend those lines which run nearest perpendicular to the shore. In most cases this plan will do substantial justice to all owners.

An equitable partition of accretion could in most cases be easily made if the operation covered a large extent of shore, and included the property of many owners. In most cases the question arises as to some one line between two adjacent owners, the next owner on either side not being interested or present, so that the question cannot be fully met or fairly solved.

In Massachusetts this difficulty is met by the statute of 1871 entitled "an act concerning the division of flats." under which one or more persons holding lands or flats adjacent to or covered by high water may apply by petition to the Supreme Judicial Court of the county in which such flats lie for the settlement of ownership in such flats. Commissioners are to be appointed to make survey of the flats of the petioners, and of all other flats adjacent and owned by other parties whose rights may be affected in determining the lines of such petioners' flats, and such other owners are to be made parties by notice, after which a general plan of division is to be made, which shall be binding upon all such parties.

It is to be hoped that as the riparian question grows in importance, in this state our legislature will pass some similar statutes, by which any riparian owners, who wish to determine their rights, may call in as parties all the owners who are interested in the same body of made land, so that the uniform plan may be adopted which shall distribute equitably and finally the whole tract.

ENGINEERING NEWS.

SATURDAY, MARCH 18th, 1876.

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NARROW GAUGE RAILWAYS.

Narrow Guage Railways were at first understood to be those of 4′ 8½″ guage, in distinction from the broad gauge of 7 ft. used by the Great Western Railway, of England, the broad gauge "par eminence" and the collossal example of the genius, force and obstinacy of the younger Brunel. The term however has now come to mean railways with a gauge of less than 3′ 6″.

The introduction of such roads from motives of economy may be easily traced to a natural reaction from the the practice of the managers of the existing lines in the following manner. With the developement of the railway system came an increase in the weight of the trains to be hauled and a corresponding increase in power and weight of locomotives, and also of the whole rolling stock, especially in the passenger departments. This increase of weight soon demanded and obtained a stronger, heavier, and more expensive rail ; but the natural tendency of business men, ignorant of the mechanical objections to such a course, soon overloaded the trains again, and thus a growth of all kinds was kept up, until the cost of a line for heavy business precluded the possibility of building in good shape a railroad which was meant for a paying investment.

At this time, engineers began to rush to the opposite extreme, and, in place of building roads which could scarcely be made heavier and more expensive, they seemed to think that the smaller and cheaper the road, and the less the first cost, the better it would be for the stockholders. Railroads can be made to cost too much, but they can also be made to cost too little ; where then shall we find the maximum value for the smallest outlays. From the time when Mr, Spooner built the " Festiniog line" which may be fairly called the parent of modern "Narrow Gauge," every man has asked this question and nearly every man seems to have found a different answer; but the greater number have chosen a gauge from 3′ 0″ to 5′ 6″, and in this country there are already quite a number of these roads with the above gauge in operation.

The object of the narrow gauge movement may be stated briefly as an attempt to limit first cost and to use a light rail under a light rolling stock. Many engineers have adopted this system because they honestly believed that it was impossible to make a light rolling stock of the ordinary dimensions, that the cost of engines, and cars was proportional to their size, or at least to their weight and that the cost of their earthwork and masonry was also exactly proportioned to the number of cubic yards of material handled and used. No arguments are so fallacious as these, for these are many items of cost which are independent of the quantities which swell the estimates, and it is only in heavy work that this assumption will be any where near the truth; certainly not in what is professedly light work. The quantities of earth and masonry for a road of average value of centre heights, say 8ft,, can only be reduced about 8 per cent, and this reduction again can scarcely be claimed as a saving of more than 5 per cent when all is considered. The great item of saving however has always been the iron, and here, in the place of 60 pounds per yard we find that 35, 30, 25 and even 20 pounds have been used, representing from 33 to 54 per cent of what has always been one of the greatest items of cost of the road. The saving in the ties is perhaps 30 per cent of material, but not over 25 per cent of money, for the reasons given above, In the rolling stock a saving in weight much greater than that of the cost is also made, Carefully weighing all things, we may safely say that not over 10 per cent of cost is saved, that is not directly connected with the diminished weight and capacity of the rolling stock ; and that, if, on a gauge of 4′ 8½″, a rolling stock of the same weight can be used as on one of 3′ 0″, the gain of the first cost can not be called over 10 per cent and will probably fall below that amount. Can we then, while retaining the 4′ 8½″ standard, diminish our rolling stock to the same amount in weight that can be used with the 3′ 0″ gauge? Scarcely to that in theory but very near to it in practice, if it be remembered that the loads carried by the cars and the speeds run have far more to do with the strength and weight than has mere distance between the rails. This distance can only govern the size of the cross-sills, and they form a very small item of the weight. If your car is, in width, only 60 per cent, of the ordinary car, it has less than 60 per cent capacity, and the size therefore, of the car cannot be of much consequence in the discussion ; and if a saving of only 10 per cent in first cost is all that can be made, we must consider that a gauge of 4′ 8½″ is alone admissible, unless the line which may be under discussion has no possibility of ever connecting with the great railway system of the country. As an instance of a short sighted view of this matter the railroads first built from St. Louis west and south may be mentioned. By the advice of a very eminent engineer they were built 5′ 0″ gauge, as he considered that there was no possibility of their ever having any connection with the roads east of the river, since it could not be bridged within hundreds of miles, and the feasability of a train ferry had never occurred to him. The cost of this mistake was enormous.

The Festiniog and all really successful imitations have been built to carry a special traffic, which could not become general by any possibility. To render mines accessible to ports of shipment, and for use upon islands is only proper service they can be put to. This important point has been lost sight of in very many instances, and we find them built as feeders to main lines, and frequently as extensions of horse railroads. Instead of the careful locations and designs which have contributed so much to the success of the " Festiniog," we find them made with results which clearly indicate that the directors have been building the road with a "cheap engineer," and that, as usual, they have paid dearly for so doing. Here a digression may be pardoned, At a recent " letting" a friend who carefully examined the work before making up his bid, said that he would be very glad to make a new location of ten or eleven miles, and thought that if the company would give him one-half of what he could save that he could make $20,000; and he could have done it. So much for the economy of cheap engineers,

That the same limits of grades and curves may be used with the common gauge as with the narrow is amply proved by the two little passenger railroads which run from Brooklyn to Coney Island, and which may be recommended to all advocates of the narrow gauge as being well worth careful study. With light locomotives, rails and cars, which, though light, will carry 80 passengers heavy grades and curves are traversed which are only exceeded by those in the station yard, at the Battery, on the New York Elevated R, R. which by the by is not a narrow gauge.

The adherents of the narrow gauge are apt to overlook the fact that, upon many of these lines, the rolling stock has already passed beyond what should be considered light, and that the engines now used by them upon light iron would not have been called light twenty-five years ago upon much heavier iron than they use now. For example, the St. Louis West End Narrow Gauge R. R. is running an 8 wheeled locomotive weighing with fuel and water, 45,000 pounds upon a rail which is 35 pounds per yard. Twenty years ago such an engine would have been put upon iron of not less than 48 lbs. yer yard.

We see then that the word economy is by no means synonymous with the term 'narrow gauge,' and it is repeated that only very exceptional circumstances can justify a departure from the standard gauge.

It is with reluctance that we feel obliged to discontinue our mathematical column, but the fact is that we have not the time to give it the attention it deserves, and being neglected it is but of little interest to our readers. It is, besides, a very expensive department to sustain, and the persons who have a genuine love for mathematical reasoning are too few in number to warrant us in the necessary expenditure for material and composition.

The present number closes the very valuable and interesting series of articles on the "Graphical Analysis of Roof Trusses," by Prof. Chas. E. Greene of Michigan University.

From their very commencement, these papers have attracted, by their simplicity of comprehension and their very practical character, the attention of engineers and architects throughout the whole country, and they have accordingly been read by thousands of members of both these professions, and so great has been the demand for them that our earlier editions of ENGINEERING NEWS are now exhausted and we cannot furnish any back numbers previous to No. 8.

We will, however, very shortly issue them in book form, when we hope to be able to present to the public in a convenient shape, one of the most useful expositions of the new and popular method of analysis, now published.

Fort Wayne Water Supply.

Fort Wayne is agitated over the question of water supply, and the Council on the evening of February 19th, listened to a report on the subject by Moses Lane, C. E. of Milwaukee.

There is no source from which to supply the city with water by gravitation, nor is there within any reasonable distance, any site sufficiently elevated for a distributing reservoir. The water supply must therefore be lifted by pumping and distributed directly from the mains.

The plan of Mr. Lane recommends the erection of a stand-pipe. He also recommends the Worthington Duplex engine. The total cost he places at $332,000.

Mr Lane in conclusion remarks —

" Allow me to say that the most important duties you will have to perform relative to the construction of the water works for your city, after you have decided to build them are the following:

1. To see that they be faithfully and substantially built.
2. That they be built without any extravagant outlay, and
3. That they be built quickly.

You are peculiarly fortunate in having a work of this magnitude to build now in your city; for you can certainly do it at a saving of at least 33 per cent. from the cost of other and similar works that have been built in this country within the last five years.

You can now obtain money on low rates of interest; and the expenditure of so large a sum on an improvement which is sure to become within three or four years at the farthest, if properly managed, a paying investment, paying both the interest on the cost and the cost of running and maintenance, cannot fail to aid almost every branch of business in your city,"

Mr. Ryall, the City Civil Engineer of Fort Wayne, in a communication to the *Daily Sentinel* of Feb. 21, takes occasion to place the many advantages of an abundant water supply before the people of that city. We did not suppose that any arguments on the subject would be necessary in a city of the size of Fort Wayne. The only matter of surprise is, that such an enterprising city should be so far behind the times, and that its 25,000 inhabitants have to depend for the water which they need for all purposes, upon wells and cisterns, with all their attendant expenses of keeping in order, of cleansing, and of guarding against contamination. Now that the subject is fairly before the people, we have no doubt we shall soon hear of a unanimous verdict in favor of the speedy construction of water works.

Prof. Cox, of Indiana, is busily engaged in testing the coke-making qualities of different coals in that state.

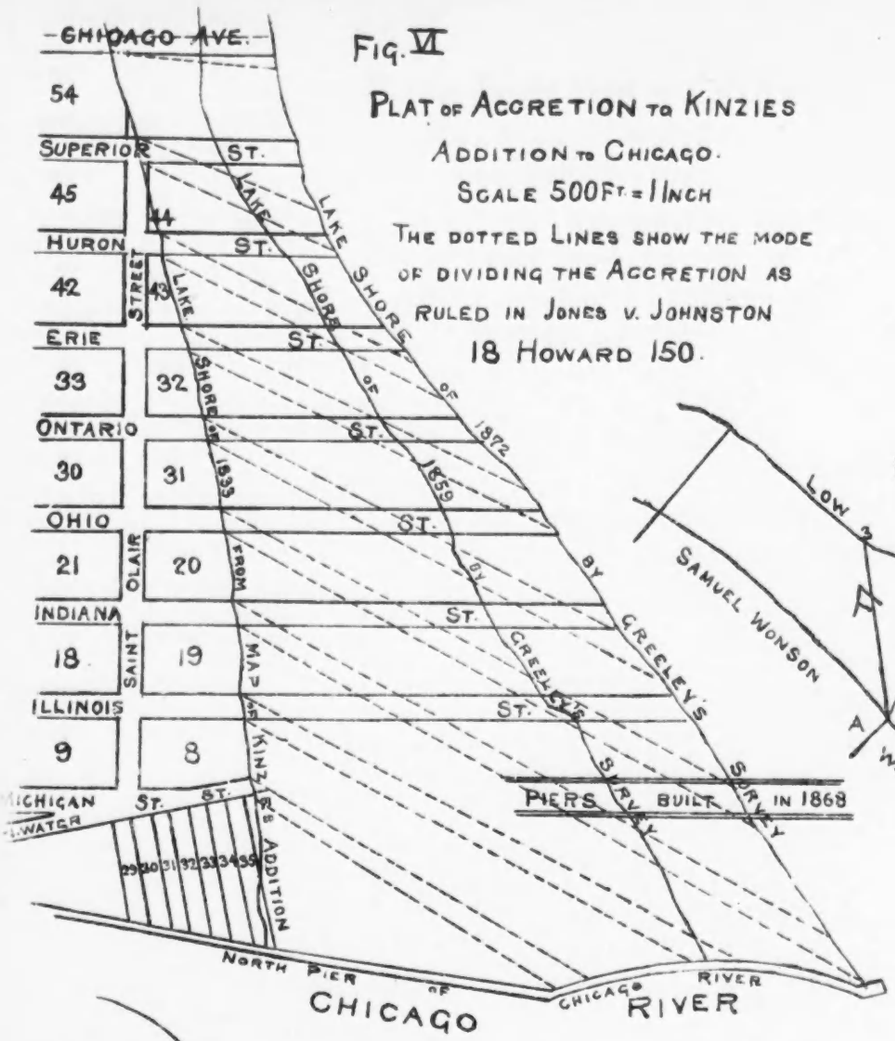

Fig. VI

PLAT OF ACCRETION TO KINZIES ADDITION TO CHICAGO.
SCALE 500 Ft. = 1 INCH

THE DOTTED LINES SHOW THE MODE OF DIVIDING THE ACCRETION AS RULED IN JONES V. JOHNSTON 18 HOWARD 150.

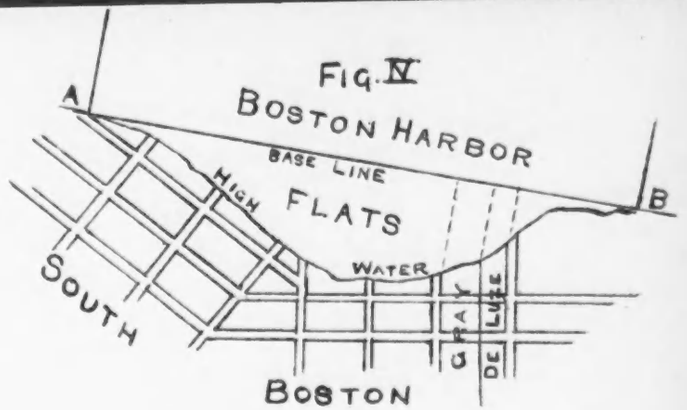

Fig. IV
BOSTON HARBOR

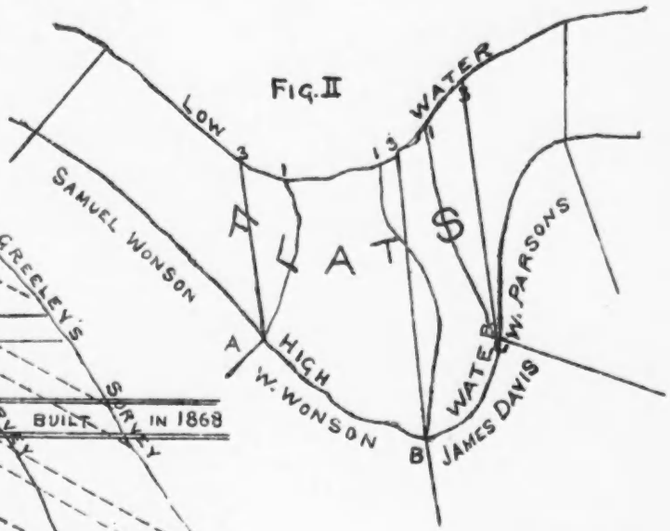

Fig. II

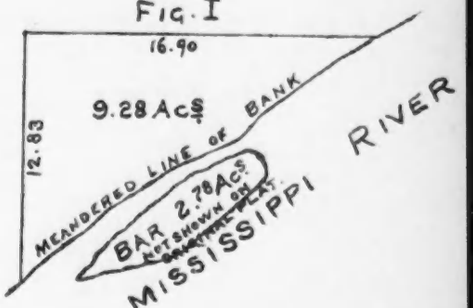

Fig. I

Fig III.

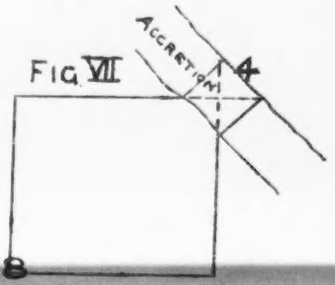

Fig VII

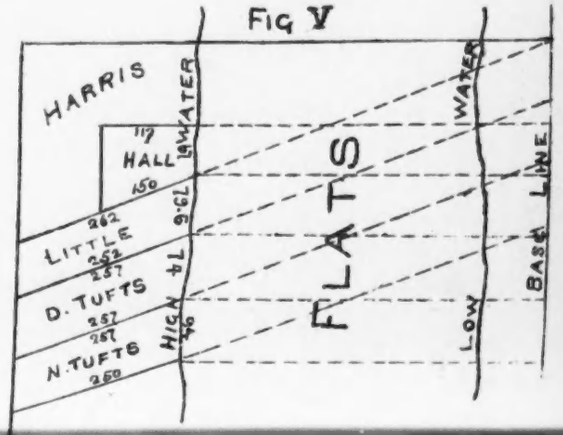

Fig V

PUBLICATIONS RECEIVED.

The Elements of Graphical Statics, and their Application to framed Structures, with numerous examples, etc., and containing new and practical Formulae for the Pivot or Draw Span, Braced Arch, Continuous Girder, etc.:—by A. Jay Du Bois, C. E., Ph. D.; New York, John Wiley & Son, 1875.

A representation to the eye of the magnitude and kind of the different stresses to which all parts of a framed structure, roof-truss, bridge-truss, or arch, are subjected, can readily be seen to possess great value to the designer. While there are a few men of such a bent of mind that only the most abstract analysis of a problem satisfies them, there is no engineer of experience who will not gladly welcome a good presentation of the graphical method of treatment.

Since structures are intended to be at rest, the principles of Statics are sufficient for the determination of the forces which act in their several parts, and, since forces can be represented by lines, it is plain that definite geometrical figures will, by their sides and areas, express the relations and magnitude of these forces. But it is hardly necessary to assure those engineers who have read the series of papers now appearing in ENGINEERING NEWS; who have drawn moment curves to ascertain the action of a load on a bridge; who have consulted diagrams for the earthwork; or who have computed indicator diagrams; that graphical methods are capable of extension to most if not all of the problems which they are called upon to solve,

It is now ten years since the work of *Culmann* on Graphical Statics first appeared in Germany, and, in that country especially, great progress has been made in extending and applying the graphical analysis. This method of treatment has been there introduced into the technical schools, and is now taught in the best schools in this country.

Prof. Du Bois offers to the American reader a clear and satisfactory presentation of what has been done by Culmann, Bauschinger, Mohr, Winkler, and others in Germany. He illustrates, from "Der Constructeur" of Reuleaux, how this analysis will readily solve problems which are troublesome when treated mathematically. The book opens with an historical and critical introduction, mainly from the pen of the German author, Weyrauch. The development of the method up to the present time is here clearly set forth, and this portion closes with a list of the literature upon the subject, very little of which is found to be in the English tongue. In the order of treatment our author then takes up the General Principle, to which he devotes some eighty pages. The resultant and balance of forces, the center of gravity, moment of rupture and moment of inertia are all discussed graphically and, as the demonstrations or constructions follow easily, one from the other, the student who possesses a knowledge of simple geometry is made acquainted with all the the principles of Statics, without needing a analytical knowledge of mechanics to enable him to recognize their truth. Here is briefly explained and illustrated that treatment of frames which has just been given in more detail and with special application, in the columns of the NEWS.

Then follows the treatment of the simple girder; the continuous girder of constant cross-section, loaded in any manner, the braced arch; the stone arch; and the inverted arch or suspension system. But as, in many cases, some useful quantities can be more conveniently obtained by mathematical calculations, the analytical investigations are often given, and the way is pointed out where a combination of both methods will shorten the work. Thus Ritter's convenient method of determining the stress on a frame is explained, and, after a few pages explaining the principles of the integral calculus, the mathematical theory of flexure of beams is given in considerable detail.

The best analytical treatment of the continnous girder to be found in English is also contained in this book. The author has availed himself of the work of Mansfield Merriman, C. E., of the Sheffield Scientific School, and has given us the extremely neat and simple results worked out by him. He has also incorporated the analsis of the draw span, supported by a center point, originated by Clemens Herschel, C. E., and to both of these writers he awards merited praise. He also cites from other authors of high repute.

The work is altogether the most valuable and comprehensive one on this subject which has yet appeared in this country. Any engineer, no matter how skilled he may be in his profession, will find much here which is new and serviceable; it cannot, however, be run over and mastered hastily. Prof. Du Bois has rendered us a substantial service in writing and compiling this book. It is printed and issued by the publishers in excellent style, the varied types making the headings, references to diagrams, etc., very distinct. After a careful examination we have found it very free from typographical errors. An atlas of plates, distinct from the text, may inconvenience the reader somewhat; but it is doubtful whether the figures could be well presented in any other manner.

The American Architect and Building Journal published by J. R. Osgood and Co., Boston, increases in in interest with each succeeding issue. No. 11, of March 11th gives the second installment of a very valuable paper on "Government Architecture and Government Architects," read by P. B. Wight of Chicago, before the Ninth Annual Convention of the American Institute of Architects, beside other information of interest to the architectural profession. This number is especially rich in illustrations, the publishers having given with it no less than five large Heliotypes of the New State Capitol at Albany, N. Y., showing the general perspective view, together with details of elevation and plan.

The architectural profession of America is to be congratulated on having such an ably conducted and beautifully illustrated journal to advocate its interests as the enterprise, liberality, and opportunities of the Messrs. Osgood and Co. are supplying it with.

Personal.

Supt. Ledyard has appointed C. C. Wheeler General Agent of the Michigan Central railroad at Detroit.

Mr. Charles Latimer, Chief Engineer of the Atlantic and Great Western railroad, will remove his office from Meadville, Pa. to Cleveland, Ohio.

John A. Cole, C. E., has been appointed Superintendent and Chief Engineer of Water Works, Town of Lake View, Cook Co, Ills., at a salary of $100 per month. The Lake View Water Works are in process of construction.

Public Improvements in Montreal.

From the report of the City Surveyor of Montreal, Canada, presented to the Council of that city on Monday, March 13, we extract the following items:

Total expenditure of the Road Department for the year ending Dec. 31, 1875, was $744,997. For removing snow, $22,470 was paid; street cleaning and watering cost $31,468; cleaning and repairing sewers cost $25,614; park improvements cost $3,981; the Colborne Avenue Tunnel cost $42,050; small sewers required, an outlay of $61,096; while $303,319 was expended for the purchase of stone and for street paving and sidewalks. Wooden blocks were at a discount, only $1919 having been expended on them. Salaries of staff amounted to about $13,000.

There were of five and six feet stone sidewalks, with chain, and water courses, constructed during the year 9.3 miles at a cost of $185,393; there were 12.325 square feet of street paving done. Geo. D. Ansley, Assistant City Surveyor, has been acting City Surveyor during the past six months in the absence of his superior officer in Europe, and in his report Mr. Ansley remarks that—"The question of road making for cities is one that is still engaging a large amount of attention from Engineers the world over, and up to this date I do not think the block stone pavement for roads subjected to heavy and constant traffic, and macadam with an overcoating of fine material for those undergoing less wear, have been superseded; but in road making as in many other things, the most careful and ably prepared calculations of the Engineer will not avail unless the contractor is kept up to the spirit of the specification throughout the smallest details in the execution of his work. The old wooden block (Nicholson) pavement on Jacques-Cartier Square has been taken up and replaced with macadam, a coating of broken grey stone one foot thick was first laid sanded and rolled with steam roller, then a coating of *banc rouge* six inches thick was laid on top, also sanded and rolled; many other of our streets have received more than ordinary attention in the way of improved grades, ballasting with macadam, etc., during the past year, details of which will be found in the schedules."

Report of Road Masters' Meeting.

We are indebted to Mr. Chas. Latimer, Chief Engineer of the Atlantic and Great Western railroad, for a Report of the proceedings of the meeting of Road Masters held at Meadville, Pa., Dec. 2, 1875, in which the numerous subjects pertaining to the duties of this most important class of railway employees are discussed in a free conversational manner, and for the purpose of learning the results of practical observation on the part of the men who are daily employed in the supervision of track repairs.

The prices of labor, best pattern and weight of rails, comparative wear of steel and iron rails, ballast, keeping track in order, and a multitude of kindred subjects are quite fully discussed.

Yonkers Water Supply.

Prof. W. Ripley Nichols of Boston, Chemist, and Col. J. W. Adams of Brooklyn, Hydraulic Engineer, experts employed by the city of Yonkers, sustained the plan for the Water Supply of that city recommended by W. W. Wilson, Chief Engineer, and Gen. George S. Greene, Consulting Engineer, and the construction of the works has been progressing throughout the season of 1875. The city has acquired title to 130.2 acres of land at cost of $68,426; the Grassy Sprain Reservoir is being built by Messrs. Davis and Kelly, Contractors; the estimated cost of same is about $48,000, of which $20,509 have been paid. Messrs, Cullen and Lawrence are building the Engine House, and Messrs. William Wright and Co. of Newburg have the contract for the engine. It is to be a compound vertical engine capable of raising in 16 hours, 1,500,000 gallons of water to a height of 225 feet, through an 18" main 4000 feet long, together with two boilers, each to be of sufficient capacity to run the engine at speed.

Diameter of high pressure cylinder	20 inches.
" " low " "	35 "
" " air pump	14 "
" " pump barrel	22 "
" " plunger	14 "
" " fly wheel	18 feet.
Weight "	20,000 pounds.
Length of stroke, of steam and water pistons and air pumps	5 feet.
Distance between end centres of beam	8 ft. 9 in.
Dimensions of condenser	6 ft. by 24 in.

The pump is Wright's Patent Bucket and Plunger; in the base there are several valve openings for suction valves, nine and one-quarter inches in diameter each; The pump is situated below the large cylinder, and the pump rod is attached directly to the piston rod of the same; it takes in water on the upstroke of the bucket, discharging one-half of the quantity at the same time and displacing the other half on its down stroke, of which a part passes through the pump barrel and through a set of discharge valves arranged on top of this auxiliary barrel, all valves in the pump are of the double beat variety.

There are to be two drop return tubular boilers:

Diameter of shell	5 feet 6 inches.
Length over all	18 feet.
Number of tubes	4
Diameter of tubes	11 inches.
Length " "	12 ft. 8 inches.
Number of flues	38
Diameter " "	4 inches.
Length " "	10 feet.
Dimensions of steam dome	36 x 42 inches.
" " mud drum, or heater	8 feet x 24 in.
Length of grate	5 feet.
Width " "	4 "

Correction.

In our editorial article of March 11, on "U. S. Land Surveying and the Metric System," for the 18th line read "The theoretical square mile is never practically a square mile."

The regular monthly meeting of the Academy of Sciences was held on Tuesday evening last, Vice President Bross in the chair, with a good attendance of members and visitors. After the usual routine business was disposed of, Prof. Marcy of Evanston, Ills., read a very interesting paper on the genus *Ammonite* of the family *Ammonitadæ*, illustrating his remarks by reference to fossil casts from the Ward Collection.

Prof. Gunning made some very interesting remarks on the comparative ages of the different races of mankind as deduced from the relations existing between the sexes in various countries, and periods of the worlds' history, after which the meeting adjourned.

C. W. B., Portland, Oregon.

In Case No. 1, the surveyed *claim* being of prior date has the preference, and the lines as originally run *on the ground* must stand.

Case No. 2. The question of ownership to the land between the Government meander lines and the low water mark of a lake or river, is now in discussion in ENGINEERING NEWS.

GRAPHICAL ANALYSIS OF ROOF TRUSSES.

BY CHAS. E. GREENE, A. M., PROF. OF CIVIL ENGINEERING, UNIVERSITY OF MICHIGAN.

XIII.

A good example of a beam whose moment of resistance is not readily determined by calculation is afforded by a deck-beam, often employed in floors and roofs, it being generally reversed from the position of Fig. 25. This example is taken from the Phœnix Iron Co's book of shapes, and is drawn to one quarter scale. The height of the section is 6 inches, breadth of flange A B 3½ inches, thickness of web, ⅜ inch, weight per yard about 44 lbs.; therefore the area of cross-section is about 4.4 sq. inches.

The readiest way to determine the moment of resistance of this cross-section is as follows:—Trace its full size from the Book of Shapes and transfer the outline to some heavy paper by going over the lines with a blunt point; cut the section from the heavy paper and determine its neutral axis by balancing it over a knife edge. Thus is found the line C D. Draw K L horizontally at the same distance from C D that S T is. A B will be projected at K L, and lines from K and L to P, the middle point of C D, or the centre of gravity of this section, will cut A B at A′ and B′, making A′ B′ the reduced length of A B, which may now be considered to have the same stress per square inch as exists at I G. In the same way the end M of M N will be projected at O, the point U at V, and the lines from O and V to P will cut the horizontal lines through M and U at new points in the desired curve. Thus enough points are determined to locate the boundary of the shaded portion from B′ to P. The portion of the web with parallel sides gives of course a triangle, found at once by drawing a line from W to P. The curve A′ P corresponds with B′ P. For the upper portion, project E F on T S, draw lines to P, and get in a similar way enough points for this curve. Cut out the two shaded figures, balance each one over a knife edge and thus determine their respective centres of gravity Q and R. Calculate the area of one; the area of the other should exactly equal it for the total tension equals the total compression. Calling this area A and the safe working stress on the square inch f, we shall then have for the moment of resistance

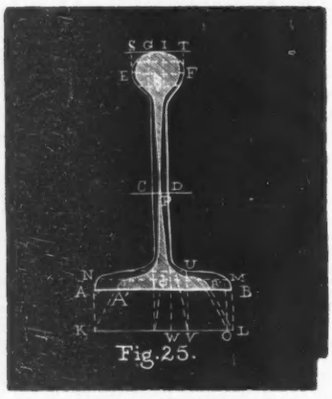

Fig. 25.

$$f.\mathrm{A}.\mathrm{P}\,\mathrm{Q}+f.\mathrm{A}.\mathrm{P}\,\mathrm{R}=f.\mathrm{A}.\mathrm{Q}\,\mathrm{R}.$$

In this example A = 1.29 sq. inches, P Q = 2.12 inches, and P R = 2.66 inches. If therefore f = 15,000 lbs., the moment of resistance equals

$$15{,}000 \times 1.29 \times 4.78 = 92{,}493 \text{ inch pounds.}$$

In simpler cases, the required size of beam to sustain a given load is more readily found by formula.

If I beams are used, the web being thin, and the top and bottom flanges alike, an approximate formula may be used. If F represents the area in sq. inches of the cross-section of either flange, W the area of the web, h the depth from centre to centre of flanges, and f the safe stress on the sq. inch, the moment of resistance is nearly equal to

$$fh\left(\mathrm{F}+\frac{\mathrm{W}}{6}\right)$$

The value of the breaking stress under a transverse load may be taken as, for wood, 9,000 to 10,000 lbs.; for wrought iron, 40,000 to 45,000 lbs. The quantities must be divided by the factor of safety, explained presently, to give f of these formulæ.

The principal trusses should be braced together in the planes of the rafters to prevent wind, in a direction perpendicular to the gable ends, from producing any lateral movement. It is often customary also to tie the trusses down to the walls, especially in open sheds, where wind may get below the roof.

It has been a very common practice to assume the steady load as 40 lbs. per square foot of roof, including truss. The various items may be computed separately, and an additional amount assumed for the frame. After the truss is roughly designed its weight should be calculated to see how well it agrees with the assumed weight. If the agreement is not sufficiently exact, the proper allowance is then to be made.

Trautwine says that, for spans not exceeding about 75 feet, and trusses 7 feet apart, the total load per square foot, including the truss itself, purlins, etc., complete, may be taken as follows:—

Roof covered with corrugated iron, unboarded	8 lbs.
" if plastered below the rafters	18 lbs.
" with corrugated iron, on boards	11 lbs.
" if plastered below the rafters	21 lbs.
" with slate, unboarded or on laths	13 lbs.
" " " on boards 1¼ in. thick	16 lbs.
" " " if plastered below rafters	26 lbs.
" " shingles on laths	10 lbs.

For spans from 75 feet to 150 feet it will suffice to add 4 lbs. to each of these totals.

The weight of an ordinary lathed and plastered ceiling is about 10 lbs. per sq. foot; and that of an ordinary floor of 1¼ inch boards, together with the usual 3 by 12 inch joists, 15 inches apart from centre to centre, is from 10 lbs. to 12 lbs. per sq. foot. White pine timber, if dry, may be considered to weigh per cubic foot, about 25 lbs., northern yellow pine, 35 lbs., southern yellow pine, 45 lbs.; if wet, add from 20 to 50 per cent.

Oak may be reckoned at from 40 to 50 lbs. per c. ft.
Cast Iron may be reckoned at 450 lbs per cu. ft.
Wrought Iron " " 480 lbs. " "

The allowance to be made for the weight of snow will depend upon the latitude. It may accumulate in considerable quantities, becoming saturated with water and turning to ice. The weight of a cubic foot is very various. Freshly fallen snow may weigh from 5 lbs. to 12 lbs.

Snow and hail, sleet, or ice may weigh from 30 to 50 lbs. per cubic foot, but the quantity on a roof will usually be small. Snow saturated with water will generally slide off from roofs of ordinary pitch. An allowance of from 12 to 15 lbs. per square foot of roof will suffice for most latitudes.

After the stresses on the frame are determined the several parts must be designed to withstand them. It is not the purpose to make here any extended remarks on the way to work up a design and get out the details, as we wished simply to explain the Graphical Method. A few suggestions however, in conclusion, in regard to the proper proportioning of the different members may not be amiss.

As materials, if repeatedly strained to an amount at all approaching the breaking strain, will fail sooner or later, the severe action weakening them, as well as to provide for unforeseen and unknown defects of material and workmanship, it is customary to so design a structure that it will require a load several times greater than the one to which it is to be submitted to break or injure any piece. The ratio of the breaking load to the actual or working load is called the *factor of safety*. For roofs and structures under a steady load this factor of safety is commonly 3 or 4, sometimes more. For structures like bridges, where the load is moveable, and where they are exposed to shocks, the factor is much larger, often double in amount, so far as concerns the moving load. The working stresses on timber are smaller fractions of the breaking stress than is the case with iron. The quality of the iron employed materially affects the force which it may safely resist.

Pieces in tension will be liable to break at the smallest cross-section. It is therefore economical of material to enlarge the screw ends of iron rods and bolts so that the cross-section at the bottom of the threads shall be at least as large as at any other point. It is desirable that the centre of resistance of the cross-section of struts and ties shall coincide with the centre of figure, as a deviation from that point weakens the piece. To calculate the net or smallest cross-section of a tension member it is sufficient to divide the force to be resisted by the safe working stress, or to multiply the force by the factor of safety and divide by the breaking strength per square inch. Let P = the force to be resisted in pounds, s = the factor of safety, f = the breaking strength in pounds per square inch of section, and A = the cross-section in square inches; then

$$\mathrm{A}=\frac{\mathrm{P}\,s}{f}$$

The value of f for tension may be taken as—for wood 10,000 to 12,000 lbs.; for wrought iron bars and bolts of small dimensions and excellent quality, 60,000 lbs.; plates and bars of ordinary quality, 45,000 to 50,000 lbs.

For very short pieces in compression, whose lengths do not exceed six times the least dimension, the same formula may be used. As the length increases the piece has a tendency to yield sideways when compressed, and the cross-section must be increased. The most comprehensive formula for such pieces is that known as "Gordon's Formula." Letting l denote the length of the piece in inches, h its *least* external diameter in inches, and a a certain constant, while the remainder of the notation is the same as above, this formula, for pieces with flat, securely bedded ends, may be written

$$\mathrm{P}\,s=\frac{f\mathrm{A}}{1+a\frac{l^2}{h^2}}$$

The following are the values of f and a:

	f	a
Wrought iron (rectangular struts);	36,000	$\frac{1}{3000}$
Cast iron (cylindrical struts);	80,000	$\frac{1}{800}$
Timber (rectangular struts);	7,200	$\frac{1}{250}$

If the struts are jointed at their ends, by pin connections, or are so narrow as to readily yield sideways at those points, use $4a$ in place of a.

If one end is firmly fixed in direction, while the other end is jotnted use $\frac{16\,a}{9}$ in place of a.

It is convenient, for cross-sections other than circles to assume h and compute A. If the other dimension then comes smaller than h, a less value must be taken for h and the calculation made anew.

For cross-sections in wrought iron not rectangles, such as **L**, **T** and **H** sections, use $1\frac{1}{2}\,l$ in place of l.

In determining the moment of resistanco of a piece exposed to bending, or in calculating the cross-section required to resist the bending moment, allowance must also be made for portions cut away in attaching fastenings, etc. A curved piece, transmitting either thrust or tension, experiences also a bending moment, as stated earlier, equal to the direct stress transmitted between its ends, multiplied by the perpendicular from the line joining its two ends to the centre line of the piece. Those pieces which resist both a bending moment and a direct stress may first be designed to safely carry the bending moment, and then the direction transverse to that in which the piece will bend may be so much increased that the added slice will resist the direct pull or thrust. If that force is thrust it will be well to test the size of the piece by Gordon's Formula also.

To rightly proportion the eyes and pins for the connection of tension bars is not an easy matter. The following rules from the Phœnix Iron Co's Pocket Book will be found serviceable:—

"Make the diameter of the pin from ¾ to $\frac{4}{5}$ of the width of the bar in flats and 1¼ times the diameter of the bar in rounds, giving the eye a sectional area of 50 per cent. in excess of that of the bar. The thickness of flat bars should be at least one-fourth of the width in order to secure a good bearing surface on the pin, and the metal at the eyes should be as thick as the bars." Many other useful details are given in the same book.

Most of the pocket and hand books issued by the different iron companies, for the use of their patrons, give the sections and weights of the various shapes of rolled bars, the usual length, the safe loads for beams of different spans, etc.

Very close attention must be given to all minor details; to so proportion all the parts of a joint that it will be no more likely to yield in one way than another; to weaken at a splice the pieces connected as little as possible; to give sufficient bearing surface, so as to bring the intensity of stress on the surface within proper limits; to distribute rivets and bolts so as to give the greatest resistance with the least cutting away of other parts. In short, a failure of a joint or connection is as fatal to a frame as to have a member too small for the stress upon it.

Contractors' Intelligence.

A stratum of zinc ore eighteen inches thick has been discovered near Cherokee, Kan.

The Globe Iron-works, Cleveland, has received the contract for the manufacture of the steel boilers for the water works of that city.

A. McAllister, of Cleveland, has been awarded the contract for building the new Lake County Infirmary The contract price is $25,585.46.

The contract for metallic cornices, etc., on the new State House, Springfield, Ill. was last Tuesday awarded to R. P Gormley, of Chicago, for $44,000.

The Keystone Bridge Company, Pittsburgh, have the contract for constructing the railroad bridge over Green river, Greenfield, Mass. The contract price is $46,850.

W. D. Richardson, of Springfield, Ill., has been awarded the contract for building an addition to the Northern State Prison located at Michigan City, Ind. His bid was $40,000, and the lowest.

The contractor for constructing the new Water Works Tunnel at Cleveland, commenced sinking the east shaft, on Wednesday, March 8th. He now has the machinery all ready and will put the shaft down at the rate of about ten feet per day.

The contract for building the court house at Quincy, has been awarded to Messrs. Larkworthy and Burge, of that city, at $218,669. The stone selected for the building is the Aux Sable sand stone. The architect of the building is Mr. John S. McKean.

It is now definitely announced that O. B. Green and Co. will complete the One Hundred and Sixth street bridge across the Calumet Rivir by April 15, so as to connect the Steel and Iron works with three railroad stations near by.—*Chicago Tribune.*

In the Ohio House, March 2d, the Senate bill to authorize the issue of $6,000,000 in bonds to complete the Cincinnati and Southern railroad was passed, after being amended by providing that the question of issuing said bonds shall be submitted to a vote of the people within thirty days from the passage of the bill.

The wonderful success of the jetty system at the mouth of the Mississippi is thought to render the project of changing the channel of the Missouri by means of a canal and revetments equally feasible, and it is proposed to adopt Captain Ead's plan of confining the current in the Portage canal, between Alton and St, Louis.

Articles of incorporation of the proposed narrow-gauge railroad from Peoria to Burlington, Iowa, were filed in the Recorder's office in Peoria, March 14. The following are the names of the incorporators: Thomas Neill, J. M. Grew, Ed. S. Eastman, C. S. Clarke, of Peoria, and John J. Rodgers, M. C. Bates, J. S. Latimer, K. R. Marks, and W. Mount, of Knox County.

Proposals for Contracts.

POLICE STATION.—Sealed proposals will be received up to noon of Thursday, March 23, 1876, at the office of the Secretary of the Board of Police, in the City Hall, Cleveland, for building the Fifth Precinct Police Station. P. L. Kessler, *Secretary.*

BRICK COAL HOUSE.—Proposals for a brick coal house to be erected on the La Salle county farm will be received at the office of H. C. Furness, Architect, until Monday 3rd day of April, 1876. Plans and specifications of same can be seen at said office where all necessary information will be furnished. G. W. Jackson, *Supt. of Poor, Ottawa, Ill.*

COURT HOUSE.—Sealed proposals in the form of a contract will be received by the undersigned at the office of H. T. Taylor, Secretary of the Building Committee, until Thursday, the 23d day of March inst., at 2 o'clock p. m., for the erection of a Court house, on the grounds now occupied by the Court house, at Racine. W. W. Vaughn, *Chairman Building Committee*, H. T. Taylor, *Secretary.*

Racine, Wis., March 1st, 1876.

United States Court House and Post Office,
Covington, Ky., Office of Supt, Mch. 6, 1875.

BRICK AND STONE WORK.—Sealed proposals will be received at this office until 12 m., March 27, 1876. for all the brick and stone work required in the construction of the basement and area walls of the United States Court House and Post Office at Covington, Ky., in accordance with plans and specifications. Copies of the drawings and specifications and any additional information may be had on application at this office. W. P. Smith, *Supt.*

DRESSED STONE WORK.—Sealed proposals will be received by the Superintendent of Construction on the "Indiana Hospital for Insane' Department for Women," until 10 o'clock a. m., Tuesday, March 21, 1876, for all the dressed stone-work required for the erection of the new Hospital for the Insane, in accordance with the plans and specifications on file in the office of Edwin May, Architect, Nos. 5 & 6 Glenn's Block, Indianapolis. The right to reject any or all bids is reserved. Address Orpheus Everts, *Supt. of Construction, Hospital for Insane, Indianapolis.*

EXCAVATION. — In pursuance of act 117 of Laws of 1859, and acts amendatory and supplementary thereto, I, the undersigned, Commissioner on the Mill Creek State Ditch, will recieve proposals or bids in writing, on the 27th day of March next, at 10 A. M., at my residence in the township of Mussey, St. Claire county, Michigan, for the excavation and construction of said ditch. Any information in regard to said work, and the kind of contract which the State will require, also dimensions of said ditch with maps and profiles, can be obtained of me at my residence at any time before the day of receiving said bids. Warren D. Churchill, *Local Commissioner.*

Mussey, St. Clair Co., Mich., Feb. 25, 1876.

BRIDGE.—Sealed proposals will be received at the office of the County Commissioners, in the city of Wilkes-Barre, Pa., until Thursday, March 23, 1876, at 2 o'clock p. m., for building a Wooden or Iron Bridge over Nescopeck Creek, in Nescopeck township, near the mill of John Driesbach. Proposals must be sealed and endorsed "Proposals for building a bridge over Nescopeck Creek, in Nescopeck Township." N. N. Dean, Samuel Line, Peter Jennings. *County Commissioners.*

Wilkes-Barre, Feb. 24.

Office of the Board of Public Works,

STAND-PIPE TOWER.—Sealed proposals will be received by the Board of Public Works, at their office, until 11 a. m., Thursday, March 23, 1876, for building a tower for stand-pipe at the pumping works on Ashland avenue and Twenty-second street, according to plans and specifications on file in said office. Proposals will be received and contracts awarded separately for mason work, carpenter work, terra cotta and roofing, painting and glazing, iron work, ane cut stone work. R. Prindiville, J. K. Thompson, Louis Whal, *Board of Public Works.*

Chicago, March 11, 1876.

COAL.—Proposals are invited for the coal supply of the Union Steamboat Co., for the season of 1876. Coal to be delivered free on board at convenient dock. Address or apply before April 1st, to W. Bullard, *General Manager.*

No. 5 Ohio St., Buffalo.

Office of Township Clerk of Bedford.

SCHOOL HOUSE.—Sealed proposals will be received by the undersigned at the office of the Township Clerk, until 12 o'clock noon of April 17th, 1876, for the construction of a brick school house in sub-district No. 1. James A. Black, George Long, Osro Osborn, *Committee on Buildings.*

Bedford, N. Y. March 13, 1876.

JAIL.—Plans and specifications for a jail to be built at Troy, Missouri, are called for, the same to be submitted to the Court in Troy on the 10th of April, 1876. The general plan of said jail to be two stories in height of brick, with four medium sized cells in the second story, and two offices in the lower story, one room for insane, and also two rooms for jailer's residence, and the total cost thereof not to exceed $10,000; the Court to select the plan and submit the building of said jail in accordance with said plan to competition.

Wm. A. Woodson, *Clerk of the County Court.*

COUNTY POORHOUSE—Sealed proposals will be received until Tuesday the fourth day of April, at 12 o'clock noon, for the building of an additional Ward to the County Poorhouse building, according to plans and specifications to be seen at the office of the County Auditor, Marion, Iowa. By order of the Supervisors. Joseph Whitney, *Chairman.*

SCHOOL HOUSE.—Sealed proposals will be received at the office of the Clerk of the Board of Education of Northampton Township, Summit County, Ohio, until 12 o'clock at noon, on the seventeenth day of April 1876, for building a School House on the lot situated in Sub-district No. 1, according to the plans and specifications on file in said office.

By order of the Board of Education,

H. A. PACKARD, *Clerk.*

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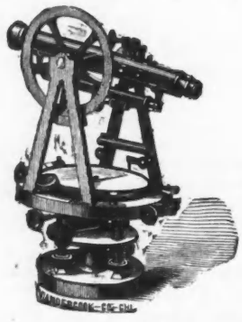

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